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Correlates of HIV Infection Among Incarcerated Women: Implications for Improving Detection of HIV Infection

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ABSTRACT *The prevalence of HIV infection in correctional settings is several-fold higher than found in community settings. New approaches to identifying HIV infection among prisoners are urgently needed. In order to determine the HIV seroprevalence and to identify the correlates of HIV infection among female prisoners, an anonymous, but linked HIV serosurvey was conducted at Connecticut's sole correctional facility for women (census=1,100). After removing all individual identifiers for inmates' standardized clinical and risk behavior information, data are linked by a third source to blinded HIV-testing information by a third party. This three-step sequential process allows for anonymous HIV testing that can still be linked with deidentified clinical and behavioral data. Of the 3,315 subjects with complete information, 250 (7.5%) were HIV+. Of these, 157 (63%) self-reported being HIV+. Using multiple logistic regression analysis, having sex with a known HIV+ person [adjusted odds ratio (AOR)=9.1] and injection drug use (AOR=6.1) were the most highly correlated risk factors for HIV, whereas leukopenia (AOR=9.4) and hypoalbuminemia (AOR=7.2) were the most significant laboratory markers. Other independent correlates of HIV included self-report of syphilis (AOR=1.9) or genital herpes infection (AOR=2.7) and being Black (AOR=2.1) or Hispanic (AOR=2.2). The prevalence of HIV and HIV-risk behaviors is high among incarcerated women. Existing voluntary HIV counseling and testing programs do not completely target high-risk groups who remain part of the evolving epidemic. Defined demographic, behavioral, and clinical assessments may provide useful information for encouraging targeted counseling and testing. Newer targeted approaches merit further study to determine the effectiveness of this approach. Alternative methods of facilitating more widespread HIV testing, such as saliva tests, rapid serologic tests, and more routine testing in high HIV-prevalence areas should be considered both for clinical and for public health benefits.*

KEYWORDS *Condoms, HIV testing, HIV, Hypoalbuminemia, Injection drug use, Prisoners, Prostitution, Risk behavior, Seroprevalence, Sexually transmitted diseases, Violence, Women.*

INTRODUCTION

Of the estimated 850,000–950,000 people in the United States living with HIV, approximately 25% are unaware of their serostatus.[1] Each year, about 40,000 new

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people are estimated to be infected with HIV; this number has not changed substantially since the early 1990s.[1] In April, 2003, the Centers for Disease Control and Prevention (CDC) set forth an initiative entitled, *New Strategies for a Changing Epidemic*, aimed at promoting early diagnosis and subsequently, early treatment of HIV infection through, among other things, increased testing outside medical settings in areas of known high HIV prevalence. Because pretest counseling for HIV can be a barrier to expanded testing, the CDC initiative now promotes HIV testing that does not require pretest counseling.[2]

Correctional systems represent important sites for the detection of HIV[3–5]; they house the nation's highest concentration of HIV-infected individuals.[6] For example, in 2000, 2.2% of all inmates in US prisons and 5.2% of all inmates in the Northeast were HIV infected.[7] In addition, approximately 20%–26% of people living with HIV infection pass through a correctional facility each year; approximately 50% of these do not know their HIV status.[8] Correctional systems also represent important sites for the initiation of medication for the prophylaxis of opportunistic infections and treatment of HIV infection.[9–11] The high concentration of HIV-infected persons in prison and jail increases the yield of identifying HIV in those settings. In Rhode Island, where HIV testing is routine for all inmates at entry and mandatory at conviction, nearly one third of all new HIV diagnoses in the state come from correctional settings.[12] Most states, however, currently rely on voluntary counseling and testing (VCT) to identify HIV infection. In Maryland, HIV VCT was accepted by 47% of the entrants; however, it identified only 34% of the HIV-seropositive inmates detected by serosurvey. Despite having multiple HIV-risk factors, HIV-seropositive individuals were more likely to refuse HIV testing.[13] Acceptance of HIV testing was subsequently found to be improved by implementing HIV testing using saliva.[14] The CDC currently promotes other strategies for HIV testing, including the use of rapid testing assays that increase uptake of testing and reduce the often-cited "waiting for results" as a barrier.[15–17] Clearly, it is important to provide a range of options for testing that address some of the frequently cited barriers, or to consider alternative means for identifying individuals who should be encouraged to get tested.

Expanding testing in correctional settings has benefits for inmates as well as the community. The identification of HIV-infected individuals while in prison allows inmates to engage in treatment at a time when they are likely to receive health care. Posttest counseling for inmates who test negative allows them to receive education about HIV prevention.[18] Because most inmates will eventually return to the community, knowledge of HIV-positive status and education about prevention will help to curb the spread of the epidemic.[19,20]

The growing HIV epidemic among women makes it essential to identify ways to increase HIV screening. Women are more likely than men to acquire HIV from injection drug use (IDU) and heterosexual transmission[21] and to present to clinical care settings with advanced HIV disease[22,23] and less likely to receive antiretroviral therapy.[24] Because the prevalence of HIV among prisoners is four to seven times greater than that in the surrounding community, and the HIV prevalence among women prisoners is greater than that found among male prisoners, we conducted an innovative prospective HIV serosurvey to determine the correlates of HIV infection among female prisoners. We sought to determine the seroprevalence of HIV infection, the medical, social, and behavioral risk factors for infection, and whether there are clinical laboratory markers predictive of HIV infection. Such information may be used to enhance targeted referrals for HIV testing when routine testing is not available.

METHODS

Study Site

All incarcerated women in Connecticut, including sentenced women and pretrial detainees, were admitted and evaluated at the sole intake facility for women, in Niantic, Connecticut. The average daily census of the facility was 1,100 women. On arrival to the facility, a standardized medical intake was conducted on all inmates, which included information regarding medical, social, sexual, and drug-use histories. Nurses performing routine clinical duties administered the questionnaire within the first 3 hours of a woman's admission to the facility. Each inmate underwent a standardized physical examination, and the morning after incarceration underwent a routine phlebotomy to obtain a complete blood count, chemistry profile, and syphilis serology (rapid plasmin reagent test, confirmed by fluorescent treponema antibody, absorbed test). Urine was tested for Beta-HCG (pregnancy test). In addition, a chest X-ray was obtained, and a purified protein derivative was placed for tuberculosis screening. Voluntary HIV counseling and testing was available by medical referral or by inmate self-request. All inmates with known HIV infection received comprehensive HIV care from a board-certified infectious disease specialist from the Yale University AIDS Program at regularly scheduled clinic visits. Antiretroviral agents available to inmates included all current U.S. Food and Drug Administration-approved therapies. After incarceration, pretrial detainees may be released on bond at any time or at court-appointed hearings.

Study Design

Anonymous HIV testing among inmates was conducted from November 1994 through October 1996 by using discard sera from routine phlebotomy. Medical intake forms, with detachable carbon copies devoid of personal identifiers, allowed the collection of all intake information while preserving anonymity. Assignment of a sequential study number to each inmate entering the facility allowed the separation of clinical and HIV serologic testing sites to preserve anonymity while permitting repeated sampling of the same individual over time (Figure).

At intake, a first study number (SN-1) from a standardized link-file form was attached to the carbon copies and to the phlebotomy tube; the latter was done only on discard sera with simultaneous removal of individual unique identifiers. Each unique individual maintained the same SN-1 irrespective of date of admission, thus allowing for repeat sampling of individuals over time. After routine laboratory testing, the discard sera, with SN-1, were sent by study personnel to the CDC for anonymous HIV-1 antibody testing. Specimens repeatedly testing positive on enzyme-linked immunosorbent assay were confirmed by Western blot analysis. The entire inmates' intake information, devoid of personal identifiers and labeled only with SN-1, was also sent to the CDC. At the CDC, both the discard sera and the intake information were assigned a corresponding second study number (SN-2), and the SN-1 was removed. Only then were HIV-serologic results linked to the intake information, using SN-2 to merge the data. The merged data set, linked anonymously to HIV-1 antibody results, was then transferred to the Yale University AIDS Program for analysis. In this manner, the Yale University AIDS Program had the only link between unique individuals and SN-1, and the CDC had the only link between SN-1 and SN-2. The Yale University AIDS Program did not provide information to the Connecticut Department of Correction regarding the identity of individuals, and the CDC did not allow for decoding from SN-2 to SN-1, thus preserving the anonymity of all inmates.

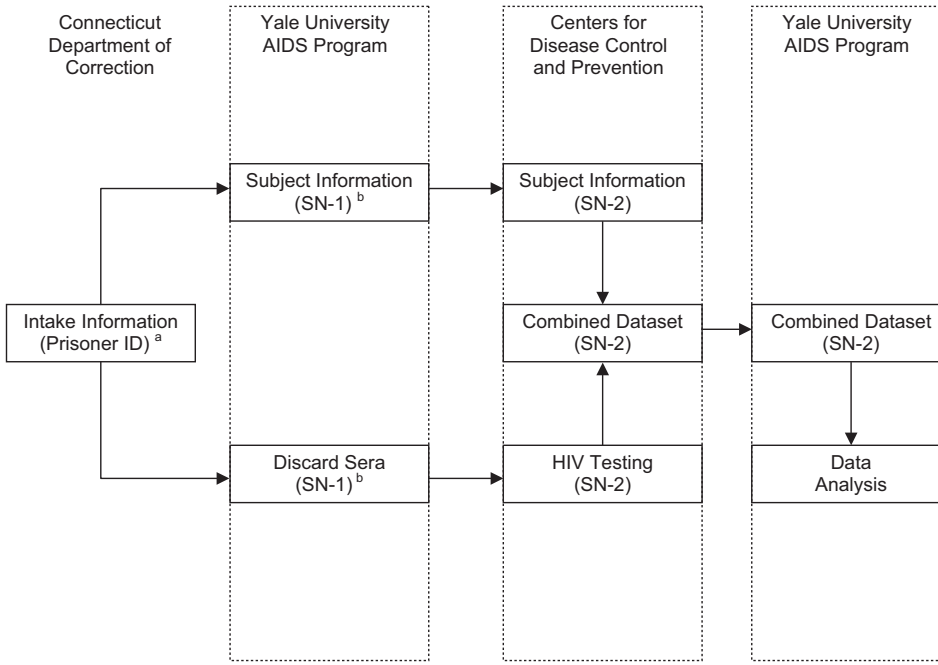

FIGURE. Study design and management of data.
[a]pretrial detainees and sentenced prisoners.
[b]all prisoner identifiers removed, same number used for repeated incarcerations.

This novel method for serial anonymous, linked serologic testing, also allows for anonymous studies of HIV seroconversion in this population. For this study, the main benefits of this methodology were to prevent duplicate sampling of inmates with more than one admission during the study period and to permit repeat opportunities for serologic testing among inmates with multiple admissions who did not have sera available from their first admission. This methodology was first developed during prior HIV serological screening programs to protect the subjects who did not provide consent for testing of discard sera.[25] Research approval for the study was obtained from the Yale University, School of Medicine (with prisoner advocate), Centers for Disease Control, and Connecticut Department of Correction Institutional Review Boards.

Definitions

HIV-1-seropositive status was defined by a repeatedly positive enzyme-linked immunosorbent assay test with confirmatory Western blot analysis. Positive syphilis serology was defined by reactive rapid plasmin reagent test serology with confirmatory fluorescent treponema antibody, absorbed test. Other sexually transmitted diseases (STD) were defined by the inmate's self-reporting the history of the disease. Illicit drug use was defined as the self-reported use of heroin, cocaine, or illegal methadone. Crack use was defined by an inmate's self-reported smoking of cocaine. IDU was defined by self-report of IDU, having a history of endocarditis, or observed needle tracks during the physical examination. Noninjecting drug use (NIDU) was defined by illicit drug use, but no IDU. All illicit drug use variables pertained to lifetime use. Sharing injecting equipment was defined by self-report of

sharing needles or injecting equipment when using drugs, and was restricted to those also meeting the criteria for IDU. Commercial sex work (CSW) was defined by self-reporting the exchange of sex for money, drugs, protection, or rent. Any violence referred to the self-report of being physically harmed, including sexual violence. Sexual violence was defined by the woman's self-report of being forced to have sex against her wishes, or being physically harmed against her will when having sex. CSW and violence variables represent lifetime exposures. All disease history variables were based on self-report. Psychiatric history included self-report of a history of a psychiatric condition, any hospitalization for a psychiatric condition, or having tried to hurt or kill oneself. Tuberculosis history included self-report of either active tuberculosis or positive purified protein derivative (PPD) test history. Racial/ethnic differences were analyzed for non-Hispanic white (hereinafter called white), non-Hispanic black (black), and Hispanic. Seventy-four people classified as "other" race (of whom 49 had HIV serologic results and two were HIV seropositive) were excluded from analyses involving racial/ethnic differences.

Analysis

For reincarcerated individuals who, at any intake during the study period, underwent phlebotomy, and whose discard sera were tested for HIV-1 antibody at the CDC, the first such intake was used as the unit of analysis. Individuals without HIV-serologic results were excluded from the subsequent analysis of predictors of HIV seropositivity.

Statistical analysis was performed by using the SAS statistical software, release 6.11. Bivariate comparisons were performed by using the chi-square test and the Student's *t* test. Multivariate analyses were performed by using fixed logistic regression models. Variables that were retained in the models were tested for interactions with each other. To avoid overfitting the data, a minimum events-to-variables ratio of 10 was maintained in the multivariate analyses.

RESULTS

Description of Study Sample

During the 23-month study period, 4,952 (71%) of 7,015 intakes were for unique individuals. Discard sera were available for anonymous HIV antibody testing from 3,315 (67%) individuals. Reasons for no discard sera included early subject release owing to meeting bond requirements, institutional lockdown that impeded transfer to medical unit for phlebotomy, and inability to perform phlebotomy. Table 1 summarizes the characteristics of the individuals with and without serologic results. In general, those with serologic results were more likely to be younger, more likely to have been reincarcerated during the study period, and less likely to be an IDU or report being HIV infected. IDUs among this sample tended to be older than non-IDUs (data not shown). In a multiple logistic regression analysis of inmates with serologic results, controlling for age and race/ethnicity, reincarceration was significantly associated with both IDU and NIDU, as well as CSW (adjusted odds ratios = 3.8, 2.1, and 1.5, respectively; data not shown).

Of the 3,315 individuals with HIV-serologic results, 250 (7.5%) tested positive for HIV (Table 2). HIV-seropositive inmates were significantly older, less educated, and were more likely to have been reincarcerated during the study period. Nonwhite inmates, black inmates in particular, were significantly more likely to be HIV seropositive. Although pneumonia, hepatitis, diarrhea, fatigue, and recent weight

TABLE 1. Characteristics of female inmates, with and without HIV-serologic results (N = 4,952)

Characteristic	With results (N = 3,315)	Without results (N = 1,637)	*P* value*
Mean age (years)	30.6	31.1	.05
Black	1,335 (41)	606 (38)	.20
Hispanic	583 (18)	312 (20)	.36
White	1,342 (41)	665 (42)	Referent
Finished high school	1,146 (49)	461 (50)	.59
Recidivist†	1,202 (36)	202 (12)	<.01
Self-report being HIV+	157 (4.7)	101 (6.2)	.03
Commercial sex work	779 (24)	359 (24)	.95
Injection drug use‡	685 (22)	413 (31)	<.01
Noninjecting drug use	1,409 (45)	563 (42)	.10
No illicit drug use	1,006 (32)	353 (27)	Referent

*For differences between those with and without HIV-serologic results, by the Student's *t* test (for age) and the chi-square test.

†Incarcerated more than once during the study period.

‡Drug use refers to self-reported lifetime use of heroin, cocaine, or methadone. Injection drug use (IDU) refers to self-reported injection drug use, history of endocarditis, or notations of needle "track marks" during physical exam.

loss by inmates' self-report were associated with seropositive status, self-reported history of psychiatric illness and tuberculosis were not. Of the 250 HIV-seropositive women, 157 (63%) self-reported themselves as being HIV infected; 37% either did not know their status or chose not to disclose it.

TABLE 2. Characteristics of HIV-seronegative and HIV-seropositive female inmates (N = 3,315)

Characteristic	HIV seronegative (N = 3,065)	HIV seropositive (N = 250)	*P* value*
Mean age (years)	30.5	32.7	<.01
Race			
White	1,264 (42)	78 (31)	Referent
Black	1,214 (40)	121 (49)	<.001
Hispanic	534 (18)	49 (20)	.04
Finished high school	1,079 (50)	67 (38)	<.01
Recidivist†	1,079 (35)	123 (49)	<.01
Psychiatric history‡	1,203 (40)	109 (44)	.17
Tuberculosis history§	151 (5)	15 (6)	.39
Pneumonia history	476 (16)	90 (36)	<.01
Hepatitis history	258 (9)	85 (35)	<.01
Current diarrhea	450 (15)	66 (27)	<.01
Current fatigue	1,020 (34)	131 (54)	<.01
Recent weight loss	918 (30)	101 (42)	<.01
Any violence¶	1,415 (65)	126 (72)	.05
Self-report HIV+	23 (1)	157 (63)	<.01

*For differences between HIV-seronegative and HIV-seropositive inmates, by the Student's *t* test (for age) and the chi-square test.

†More than one intake during the study period.

‡Self-report of a history of a psychiatric condition, any hospitalization for a psychiatric condition, or trying to hurt or kill oneself.

§Self-report of either tuberculosis or positive purified protein derivative test.

¶Self-report of being physically harmed, including sexual violence.

Bivariate Correlates of HIV Infection

Drug-related risks associated with HIV-seropositive status are described in Table 3. Both IDU and NIDU were associated with HIV infection. Among IDUs, sharing injecting equipment was strongly correlated with HIV seropositivity (OR = 5.2, 95% CI = 3.7–7.5). Among inmates reporting any drug use, heroin was associated with HIV infection, whereas cocaine did not have a significant association. The daily consumption of alcohol was also associated with a two-fold increased risk of HIV infection. Crack use showed a trend toward a negative association with HIV seropositivity.

Sex-related risks for HIV infection are presented in Table 4. Women reporting sex with a partner who they believed to be HIV-infected had an 18-fold increased risk for being HIV-seropositive. Both IDU and NIDU were significantly associated with an inmate's self-report of sex with an HIV-infected partner ($P < .01$ for both IDU and NIDU; data not shown). Self-reporting sex with an IDU conferred over a three-fold risk for being HIV infected, whereas sex in exchange for money, drugs, protection, or rent (CSW), and sex with strangers had a three- and two-fold increased risk, respectively. Among the HIV-seropositive CSWs, 67% were also IDUs (data not shown). Overall, STD were associated with a greater than two-fold risk for HIV infection, whereas ulcerative infections such as herpes and syphilis each conferred a four-fold risk.

Interestingly, always using condoms had a significant association with seropositive status. HIV-seropositive women who also self-reported HIV-infected status were more likely to report always using condoms, compared with HIV-seropositives who reported being HIV negative ($P = .01$; data not shown). A history of sexual violence was significantly associated with HIV infection, whereas nonsexual violence was not (data not shown). Both IDU and NIDU were significantly associated with an inmate's self-report of sex with an HIV-infected partner ($P < .01$ for both IDU and NIDU; data not shown).

TABLE 3. Bivariate analysis of drug-related risks among HIV-seronegative and HIV-seropositive female inmates

Characteristic	Number HIV tested (N = 3,315)	Number HIV seropositive [N = 250 (7.5%)]	Odds ratio (95% confidence interval)*
No illicit drug use	1,006	25 (10)	Referent
Injection drug use†	685	140 (59)	10.1 (7.0–14.6)
Noninjecting drug use	1,409	74 (31)	2.2 (1.4–3.4)
Among drug users			
Heroin use	1,070	149 (72)	2.4 (1.8–3.3)
Cocaine use	1,802	184 (88)	1.1 (0.7–1.7)
Crack use	1,177	104 (55)	0.7 (0.5–0.9)
Shared injection equipment‡	239	72 (30)	5.2 (3.7–7.5)
Daily alcohol use§			
No	1,810	114 (46)	Referent
Yes	494	62 (25)	2.1 (1.5–2.9)

*Odds ratio for HIV seropositivity, using the chi-square test.

†Drug use refers to self-reported use of heroin, cocaine, barbiturates, or methadone. Injection drug use (IDU) refers to self-reported injected drug use or history of endocarditis or observation of needle track marks during physical exam.

‡Self-reported sharing of needles or injecting equipment when using drugs.

§In the month before incarceration.

TABLE 4. Bivariate analysis of sex-related risks among HIV-seronegative and HIV-seropositive female inmates

Characteristic	Number HIV tested N = 3,315	Number HIV seropositive N = 250	Crude odds ratio (95% confidence interval)*
Sex with HIV+ partner†			
No	2,966	143 (5)	Referent
Yes	188	89 (47)	17.7 (13.7–23.0)
Commercial sex work			
No	2,428	129 (5)	Referent
Yes	779	115 (15)	3.1 (2.4–4.0)
Multiple sex partners‡			
No	1,810	129 (7)	Referent
Yes	461	43 (9)	1.3 (0.9–1.9)
Sex with strangers§			
No	190	14 (7)	Referent
Yes	493	67 (14)	2.0 (1.1–3.6)
Sex with an injection drug use			
No	2,895	214 (7)	Referent
Yes	311	33 (13)	3.4 (2.2–5.2)
Always uses condoms¶			
No	2,138	130 (6)	Referent
Yes	973	99 (10)	1.8 (1.3–2.3)
Genital herpes			
No	3,150	217 (7)	Referent
Yes	110	26 (24)	4.2 (2.7–6.4)
Syphilis			
No	2,982	188 (6)	Referent
Yes	281	58 (21)	3.9 (2.9–5.2)
Genital warts			
No	3,095	220 (7)	Referent
Yes	157	23 (15)	2.2 (1.4–3.5)
Gonorrhea			
No	2,674	168 (6)	Referent
Yes	590	78 (13)	2.3 (1.7–3.0)
Chlamydia			
No	2,834	213 (8)	Referent
Yes	430	33 (8)	1.0 (0.7–1.5)
Any of the above sexually transmitted diseases			
No	2,203	123 (6)	Referent
Yes	1,064	123 (12)	2.2 (1.7–2.9)
Sexual violence**			
No	1,394	82 (6)	Referent
Yes	953	93 (10)	1.7 (1.3–2.4)

*Odds ratio for HIV seropositivity, using the chi-square test (row percentages in parentheses).

†Self-reported sex with someone believed to be HIV infected.

‡More than one male sexual partner in the past month.

§Sex with a male partner who was not the inmate's primary sexual partner.

¶Self-reported condom use in the 6 months before incarceration.

**Inmate's lifetime self-report of being forced to have sex against her wishes or being physically harmed against her will when having sex.

A multiple logistic regression analysis using all variables with a *P* value <.10 from the bivariate analyses along with age and race/ethnicity determined the relative impact of important risk factors for HIV infection. Demographics, drug use, and sexual risk were all independently associated with HIV seropositivity. Sex with an HIV-infected partner was the single largest independent predictor of HIV infection. IDU exhibited a significant association with HIV infection apart from the association seen for sharing injecting equipment. Ulcerative STD such as genital herpes and syphilis also maintained significant associations. Interestingly, even when controlling for specific drug- and sexually related risk factors, black and Hispanic women were still more likely than white women to be HIV infected.

Laboratory Predictors of HIV Infection

Bivariate and multivariate analyses for laboratory abnormalities, as they are associated with HIV infection, are summarized in Table 6. Leukopenia, hypoalbuminemia, elevated hepatic transaminases, and positive syphilis serology all remained significant, independent of the presence of other laboratory abnormalities. Laboratory variables shown to be significant in the multivariate analysis (those for leukopenia, hypoalbuminemia, elevated hepatic transaminases, and positive syphilis serology) were placed in a multiple logistic regression model with the variables summarized in Table 5. Leukopenia and hypoalbuminemia were still significantly associated with HIV infection in the presence of the social and behavioral risk factors in the model (Table 7).

DISCUSSION

The minimum HIV seroprevalence among the female prisoners and pretrial detainees in Connecticut who were tested anonymously in this study was 7.5%. Because this women's correctional facility houses both sentenced and unsentenced women, the HIV prevalence may differ between these two groups. Though individuals who were reincarcerated were overly represented in the group who had available sera,

TABLE 5. Multiple Logistic regression analysis of risk factors for HIV among female inmates

Characteristic	Adjusted odds ratio (95% confidence interval)*	*P* value
Sex with HIV+ partner†	9.8 (6.8–14.3)	<.0001
Injection drug use‡	5.9 (3.6–9.7)§	<.0001
Noninjecting drug use	1.4 (0.9–2.3)§	.16
Genital herpes	3.1 (1.7–5.5)	<.001
Syphilis	2.2 (1.5–3.3)	<.001
Black	2.4 (1.7–3.6)¶	<.0001
Hispanic	1.7 (1.1–2.7)¶	.02

Age as a continuous control variable.

*Multiple logistic regression, with all listed variables as the predictors, and HIV-seropositive status as the outcome.

†Self-reported sex with someone believed to HIV infected.

‡Injection drug use (IDU) refers to self-reported injection drug use or history of endocarditis or observation of needle track marks during physical exam.

§No illicit drug use as referent.

¶White as referent.

TABLE 6. Crude and adjusted odds ratios for laboratory abnormalities associated with HIV-seropositive status among female inmates

Laboratory abnormality	Number tested (N = 3,315)	Number HIV seropositive N (%)	Crude odds ratio(95% confidence interval)*	Adjusted odds ratio (95% confidence interval)†
Leukopenia‡				
No	2,920	156(5)	Referent	Referent
Yes	167	75(45)	14.4(11.0–19.1)	11.6(7.8–17.3)
Hypoalbuminemia§				
No	2,992	191(6)	Referent	Referent
Yes	86	34(40)	9.6(6.6–14.0)	5.3(2.9–9.9)
Elevated hepatic transaminases¶				
No	2,512	122(5)	Referent	Referent
Yes	566	103(18)	4.4(3.4–5.7)	3.6(2.6–5.0)
Positive syphilis serology**				
No	2,868	185(6)	Referent	Referent
Yes	205	39(19)	3.4(2.4–4.9)	3.2(2.1–5.0)
Anemia††				
No	2,813	186(7)	Referent	Referent
Yes	275	46(17)	2.8(2.0–4.0)	1.3(0.8–2.1)
Macrocytosis‡‡				
No	2,934	213(7)	Referent	Referent
Yes	155	19(12)	1.8(1.1–2.9)	0.9(0.5–1.8)
Thrombocytopenia§§				
No	2,986	202(7)	Referent	Referent
Yes	77	24(31)	6.2(4.0–9.7)	0.9(0.5–1.9)

Age controlled for as a continuous control variable.
*Odds ratio for HIV seropositivity, using the chi-square test (row percentages in parentheses).
†Multiple logistic regression, with all listed variables as the predictors, and HIV-seropositive status as the outcome.
‡White blood cell count <4,000 cells/mL.
§Albumin <3.5 mg/dL.
¶AST >31 IU or ALT >36 IU.
**Positive plasmin reagent test with confirmatory fluorescent treponema antibody, absorbed test.
††Hematocrit <35%.
‡‡Mean corpuscular volume >99.
§§Platelets <150,000/mL.

TABLE 7. Multiple logistic regression analysis of correlates of HIV infection among female inmates

Characteristic	Adjusted odds ratio (95% confidence interval)*	*P* value
Sex with HIV+ partner†	9.1 (5.9–14.1)	<.0001
Injection drug use‡	6.1 (3.5–10.7)§	<.0001
Noninjecting drug use	1.7 (1.0–2.9)§	.06
Genital herpes	2.7 (1.3–5.2)	<.01
Syphilis	1.9 (1.2–3.0)	<.01
Black	2.1 (1.3–3.2)¶	.001
Hispanic	2.2 (1.3–3.6)¶	<.01
Leukopenia	9.4 (5.8–15.0)	<.0001
Hypoalbuminemia	7.2 (3.8–13.6)	<.0001

Age controlled for as a continuous control variable.

*Multiple logistic regression, with all listed variables as the predictors, and HIV-seropositive status as the outcome.

†Self-reported sex with someone believed to HIV infected.

‡Injection drug use (IDU) refers to self-reported injected drug use or history of endocarditis or observation of needle track marks during physical exam.

§No illicit drug use as referent.

¶White as referent.

those without available serum for HIV testing were more likely to be IDU or self-report HIV infection (two groups strongly correlated with HIV infection). This HIV prevalence, however, is similar to that seen in prisons in the northeastern United States.[7] The greater reincarceration of the HIV-seropositive inmates during the study, and the extent to which IDU, NIDU, and CSW were independently associated with reincarceration, indicate that there is ample opportunity to access individuals who are at high risk for HIV infection, and to provide them with appropriate HIV testing, treatment, and risk-reduction interventions.

It has been estimated that less than half of prisoners with HIV infection know their HIV status, leaving the remainder without receipt of appropriate and needed HIV-care services.[8] This study indicates that a substantial proportion of HIV-seropositive female prisoners did not know their HIV status. Studies elsewhere demonstrate a relatively low uptake of VCT. In Maryland, 39% of prisoners accepted VCT; however, those with the highest risk for HIV did not accept it.[26] In a collaborative screening program in five large jails, HIV VCT of 1,020 prisoners yielded an overall HIV seroprevalence of 17%. Most of these, however, were confirmatory testing of known HIV seropositives; relatively few individuals with newly identified HIV were identified using this approach.[27] Moreover, although CDC-funded VCT programs in the United States have demonstrated marked increase in testing overall, the percentage of positive tests among traditionally high-risk individuals (e.g., men who have sex with men, IDUs, blood transfusions) has decreased, and the proportion without identifiable risk behavior has increased.[28] This lack of identifiable risk factors in this study suggests the need for the expansion of "traditional" HIV-risk factors. In addition, newer testing methods such as saliva testing and rapid testing, may be useful in decreasing patient-level or system–level barriers to testing, and more routine testing in high-prevalence areas should be strongly considered for both clinical and public health benefits.

In this study, many additional correlates were determined that can be used to enhance targeted HIV testing among female prisoners. In contrast to other serosurveys

among male prisoners, this study of female prisoners confirms self-reported sex with an HIV-infected partner as an independent risk for HIV.[13] Similar to other studies, the major independent risk factors for HIV infection in this sample were IDU, genital herpes, syphilis, and black race. IDUs made up 59% of the HIV-seropositive women in this study, of whom 51% reported sharing injecting equipment. The overall IDU rate among the sample (22%), however, was lower than that seen among other prison samples.[29,30] With over 40% of women not disclosing "traditional" IDU risk behaviors, and in the absence of mandatory or routine HIV testing, alternative approaches to identifying HIV-infected prisoners need to be developed. The intermediate proportion of IDU-related HIV infection seen here may reflect gender differences in susceptibility to HIV infection as well as differences in HIV-risk behavior and suggests the need to expand criteria for HIV testing among this population.

Ulcerative STD, herpes and syphilis remained as independent risk factors for HIV infection. The associations seen with gonorrhea and genital warts in the bivariate analysis may also indicate the importance of nonulcerative STD in HIV infection, as has been suggested in other studies.[31] In addition to acting physiologically to enhance HIV transmission, STD may also act as markers of sexual risk behaviors. An important interaction between drug use and sexual risk taking is indicated by the degree to which sex with an HIV-infected partner was associated with both NIDU and IDU. The extent to which IDU risks and sexually related risks may overlap suggests the need for combined risk-reduction interventions that promote both safer sexual behavior and safer injection practices.[32]

Despite adjusting for specific risk factors related to drug use and sexual behavior, black women still had an increased risk of HIV infection. This phenomenon was also observed among black male prisoners in Connecticut.[25] An increased odds ratio for HIV infection among blacks after adjustment for STD and high-risk sexual practices was noted in another study of men who have sex with men.[33] Some of the differences in HIV infection seen among black women in this study may be because of inadequate measurement of different drug-using behaviors among this group, including different practices regarding sharing of injection equipment. There is also the possibility that an increased prevalence of HIV in these women's social networks may put them at higher risk for HIV infection.[25]

The potential use of routine clinical laboratory markers to screen for HIV risk is suggested by the finding that leukopenia and hypoalbuminemia are both strongly associated with HIV infection, independent of the risk factors discussed above. These findings are consistent with those reported for laboratory abnormalities that were predictive of later diagnosis with AIDS among mostly male inmates in New York State[34] and in sentenced male prisoners in Connecticut. Among certain groups of women, such as urban adolescents[35] or those attending inner-city prenatal clinics,[36] use of "traditional" risk categories has been found to miss many who are HIV infected. In certain cases, therefore, routine laboratory tests may be useful in determining those at higher risk. In settings where intake risk behavior information is minimal, or where routine laboratory testing is not available, alternative HIV screening programs should be considered. Mandatory HIV testing of sentenced prisoners has been feasible in Rhode Island and has resulted in diagnosis of over 30% of all HIV cases statewide.[5]

The high degree of awareness of HIV-infection status (63%) may be a marker for many past experiences with the correctional system where a woman may repeatedly access HIV testing. This is supported by the high rate of recidivism among this group. Drug treatment or other VCT experience among these women outside of the

correctional system may also explain this awareness. The previous demonstration of a high level of adherence to HIV medications in this same sample indicates that these women are obtaining important HIV care in Connecticut's correctional system. The need for such care is suggested by the finding that 67% of these women were first offered therapy in the correctional setting.[11,37]

Approaches to improve identification of HIV among female prisoners have important implications for HIV transmission. Reported condom use among women who self-identified as being HIV infected was more consistent than condom use among HIV-seropositive women who did not identify as being HIV infected or women who were HIV negative. It therefore appears that knowledge of HIV-seropositive status is associated with reduction in sexual risk taking. This finding is consistent with a study of female prisoners in Québec[38] and in male prisoners in Connecticut[25] who were more likely to use a condom compared with their HIV-seronegative counterparts.

The novel methodology used in this study permitted linkage of risk behaviors, medical history, and routine laboratory information to HIV serostatus while maintaining the anonymity of individuals. By using this anonymous methodology to follow a cohort of high-risk women entering a correctional facility, we avoided the selection biases of other population-based studies, particularly cohort studies that rely upon self-selected enrollment.[39] Such a methodology also permits the resampling of individuals to estimate HIV seroincidence for female prisoners in general. An HIV seroincidence of 7.4%—higher than any of the other six sites of street-recruited active drug users—was calculated for a substudy of HIV-seronegative IDUs at this site.[40]

CONCLUSIONS

The prevalence of HIV among female prisoners remains high. A significant minority of these women did not appear to be aware of their HIV-seropositive status. The identification of their HIV infection could result in benefit from antiretroviral therapy and other preventive measures if routine testing strategies had been deployed. A combination of risk behaviors and laboratory markers may increase the identification of HIV among female prisoners if systematically used with subsequent referral for VCT. Such markers for HIV, however, are not uniformly assessed in busy correctional settings where time is often limited and resources for laboratory testing are constrained. In lieu of the practical limitation of ineffective screening programs, more proactive HIV-testing strategies should be assessed. Finally, the confirmation of HIV-seronegative status would identify a substantial number of HIV-seronegative women who would be ideal targets for HIV risk-reduction interventions.[41,42] This study demonstrates that correctional facilities are excellent sites for the implementation of primary and secondary HIV prevention and HIV treatment activities and, as such, have important policy implications for prison health facilities and national HIV prevention and treatment strategies.

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